UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/881,408	06/13/2001	Kie Y. Ahn	MI22-1534	8492

21567 7590 06/27/2003

WELLS ST. JOHN ROBERTS GREGORY & MATKIN P.S.
601 W. FIRST AVENUE
SUITE 1300
SPOKANE, WA 99201-3828

EXAMINER
LE, THAO X

ART UNIT	PAPER NUMBER
2814	

DATE MAILED: 06/27/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/881,408	Applicant(s) AHN ET AL.
	Examiner Thao X Le	Art Unit 2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *31 March 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-31,52 and 54-59* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *56,57 and 59* is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☒ Claim(s) *10-12* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 May 2002* is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *16* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

1. The indicated allowability of claim 58 is withdrawn in view of the newly discovered reference(s) to Ota. Rejections based on the newly cited reference(s) follow.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1-2, 6-8, 13-15, 18-20, 24-25, 29-31, 52, 54 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pub 2002/0047170 to Ota.

Regarding to claim 1, Ota discloses in fig. 1-6 a method of forming a dielectric layer comprising: a substrate 1 comprising a silicon-containing surface, forming a first metal-containing dielectric layer 21 over the surface, all the metal comprising of the first dielectric

layer consisting of at least one element selected from group IVB of the periodic table, forming a second metal-containing dielectric layer 22 on and in contact with the first metal-containing dielectric layer 21, all the metal of the second dielectric layer consisting of at least one element selected from Group IIIB of the periodic table, [0075]-[0077].

Ota discloses the layer 21 comprises $HfSiO_2$ and layer 22 comprises HfO_2 [0075]. But Ota also discloses the metal can be Zr (belongs to group IVB) or La (belongs to group IIIB). At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the teaching of Ota as claim, because it would have considered a mere substitution of art-recognized equivalent values.

Regarding to claims 2, Ota teaches the first metal-containing dielectric layer 21 consists of hafnium, [0075].

Regarding to claims 6, 7, Ota teaches the second metal-containing dielectric layer comprises an element selected from group IIIB of the periodic table, where the second metal-containing dielectric layer comprises lanthanum, [0077].

Regarding to claims 8 and 24-25, Ota discloses the method wherein forming of the first metal-containing dielectric and the forming of the second metal-containing dielectric layer comprise: forming a hafnium-containing layer 21, forming a lanthanum-containing layer 22, over the hafnium-containing layer, and exposing the hafnium-containing layer and lanthanum-containing layer to a oxygen comprising atmosphere, and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer, [0075]-[0077].

Regarding to claims 13-15 and 18, 29-31 Ota does not expressly disclose the ratio of the hafnium thickness to the lanthanum thickness of about 1 to 3 to about 1 to 4, from about 4:1 to about 1:4.

But Ota discloses forming the hafnium-containing dielectric layer 21 to a thickness less than or equal about 5 nm, and forming the lanthanum-containing dielectric layer 22 to a thickness less than or equal about 5 nm [0075]. Accordingly, it would have been obvious to one of ordinary skill in art to use the teaching of Ota in the range as claimed, because it has been held that where the general conditions of the claims are discloses in the prior art, it is not inventive to discover the optimum or workable range by routine experimentation. See In re Aller, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1955).

Regarding to claims 19, 25, Ota discloses the first metal-containing dielectric layer consist of hafnium oxide and the second metal-containing dielectric layer consist of lanthanum oxide, [0075]-[0077].

Regarding to claims 20, 52, 54, 55 as discussed in the above claims1 Ota discloses all the limitation of claim 20 including forming a MOS transistor in fig. 1 comprising a gate electrode 3 over the hafnium-containing and lanthanum-containing dielectric layers.

5. Claims 3-5, 23, 27, 58 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pub. 2002/0047170 to Ota in view of US Patent 6,184,072 to Kaushik et al.

Regarding to claims 3, 23, 27 Ota does not expressly disclose the method further comprising: forming a silicon dioxide layer overlying at least one portion of the surface, and wherein forming the first metal-containing dielectric layer comprises forming a metal layer over

the layer of silicon dioxide, and combining the metal layer with oxygen of the silicon dioxide layer to form a metal oxide dielectric material.

However, Kaushik reference discloses forming a silicon dioxide layer 14, fig. 1, column 2 line 30 and 60, overlying at least one portion of the surface, forming the a hafnium metal layer 16, fig. 2, column 2 line 47 and column 3 line 2, over the layer of the silicon dioxide; and combining metal layer with oxygen of the silicon dioxide layer to form a metal oxide dielectric material 18, fig. 3, column 3 line 13-30. At the time of the invention was made; it would have been obvious to one of ordinary skill in the art to combine the metal layer with oxygen of the silicon dioxide layer teaching of Kaushik with Ota method to form a first metal dielectric material, because it would have created a high-K dielectric layer as taught by Kaushik, column 3 line 28.

Regarding to claim 4, Ota discloses the first metal-containing dielectric layer 21 comprises hafnium, [0075].

Regarding to claim 5, Ota does not expressly disclose the combining comprises providing conditions effective to the hafnium of the metal layer to chemically reduce the silicon dioxide layer.

However, Kaushik reference discloses the combining comprises providing conditions effective to the hafnium of the metal layer to chemically reduce the silicon dioxide layer, column 3 lines 13-30. At the time of the invention was made; it would have been obvious to one of ordinary skill in the art to combine the chemically reduce the silicon dioxide layer by hafnium of Kaushik with Ota method, because it would have

achieved an optimal increase in dielectric constant as taught by Kaushik, column 3 line 11.

Regarding to claim 58, as discussed in the above claims 1, 3, the combination of Ota and Kaushik discloses all the limitation of claim 58.

6. Claims 9, 16-17, 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pub. 2002/0047170 to Ota in view of US Patent 6,399,521 to Zhang et al.

Regarding to claims 9, 16-17, 21-22 Ota discloses the gate dielectric is deposited by conventional techniques such as CVP [0075]. In addition, Zhang discloses the CVP, PVD, & MOCVD processes to deposit hafnium-containing layer 14 fig. 3, column 5 line 51. At the time of the invention was made; it would have been obvious to one of ordinary skill in the art to select the deposition process as disclosed above, because such processes have been commonly used in the art and can be used interchangeably.

Allowable Subject Matter

7. Claims 10-12, and 28 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

- With respect to claim 10, the prior art of record fails to disclose all the limitation in claim 10, including the exposing comprises ion bombardment of the hafnium layer and the lanthanum-containing layer using and ion bombardment energy of about 10 EV or less.

- With respect to claim 11, the prior art of record fails to disclose all the limitation in claim 11, including the heating comprises heating the temperature from about 200°C to about 400°C during the ion bombardment.

- With respect to claim 12, the prior art of record fails to disclose all the limitation in claim 12, including the exposing to oxygen radicals.

- With respect to claim 28, the prior art fails to disclose all the limitations in claim 28, including providing ion bombardment of the hafnium layer and the lanthanum-containing layer using and ion bombardment energy of about 10 EV or less and where the heating to an effective temperature comprises heating while providing ion bombardment to a temperature from about

8. Claims 56-57 and 59 are allowed.

- With respect to claims 56 and 59, the prior art fails to disclose all the limitations of the base claims 56 and 59 including exposing the hafnium-containing layer and the lanthanum-containing layer to an oxygen comprising atmosphere by ion bombardment using an energy of about 10 eV or less.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thao X Le whose telephone number is 703-306-0208. The examiner can normally be reached on M-F from 8:00 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael M Fahmy can be reached on 703-308-4918. The fax phone numbers for the

organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Thao X. Le
May 22, 2003

PHAT X. CAO
PRIMARY EXAMINER